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ABSTRACT

Effective involvement in early reading instruction is predicated on the pupil's ability to scan, encode, and retrieve the appropriate visual/aural language information. This paper specifies these components for the purpose of providing input to a program that seeks to induce children to successfully and continuously participate in elementary-level instruction. The first section of the paper outlines an analysis of the processing tasks thought to be central to initial reading. The second section is an attempt to abstract general processing factors from the detailed analysis. (Author)

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PROCESSING COMPONENTS OF INITIAL READING

Leon Manelis

This paper focuses on the perceptual and memorial aspects of reading, although higher level conceptual skills are introduced for the sake of completeness. The reading level assumed throughout is K-1. Reflecting this is the analysis on decoding. A model of decoding is assumed in which a novel word or a word not known by sight is visually segmented into letters and letter clusters, sounds are assigned to the letters and letter clusters in accord with letter-sound correspondences, and the sounds are "blended" into an integrated word. The approach to decoding as well as to other processes in initial reading is to attempt to identify functional units in the display presented to the child and to describe the relations among the units and the manner of operating on them.

The enterprise of analyzing reading into component processes is not unique to this paper (Koehler, 1969; Marsh, 1969, Koehler, 1970; Singer & Ruddell, 1970; Davis, 1971, Rudegeair, 1972). The present discussion overlaps prior analyses in many ways. The particular purpose here, however, is to emphasize low level skills in children with special attention to skills useful in instructional situations. This type of description is pertinent to the initial work on Instructional Participation Skills. The rationale is that there are teachable skills enabling children to efficiently process information presented

in classroom instruction. A major concern is with the child's motivation to participate and, in particular, with the motivation that can be derived from proficienty in the processing skills themselves. The present discussion is an attempt to detail skills that may be useful for successful performance in initial reading. Similar analyses will be performed on other areas of K-1 instruction. The skills, sets and attentional factors common to early instructional contents will subsequently be specified and used to generate hypotheses, models, and research strategies that will serve in developing content for the Instructional Participation Skills Program.

This paper is divided into two main sections. The first consists of an elaborate table and an accompanying commentary. The table outlines tasks thought to be central to initial reading and gives an analysis of each in terms of functional units and processing strategies and requirements. The second section of the paper is an attempt to abstract general processing factors from the detailed analysis.

ANALYSIS OF INITIAL READING COMPONENTS

Table 1 outlines an analysis of tasks in initial reading. The first four tasks are aspects of word decoding: visual segmentation, assigning sounds to letters, blending, and sight-word identification. The next two tasks are very general aspects of comprehension: reading stories and answering comprehension questions. The final task, "selecting a target among alternatives," describes a common paradigm in phonics instruction: the child is required to select one item among several presented on the basis of its correspondence to a given target; for example, the words hit, sit, pit might be presented visually with the instruction to point to the word that says /pit/.

Each task is described in a column of the table. The rows give various characteristics of each task. The headings for the rows are

TABLE 1

ANALYSIS OF INITIAL READING COMPONENTS

TASK	visual segmentation	assigning sounds to letters	blending
STIMULUS	visual word	single letters, word fragments, whole words, all as visual displays	set of ordered sound components
FUNCTIONAL UNITS WITHIN STIMULUS	letters	single letters, secondary vowels, consonant digraphs, VC(C) units, syllables	phonemes and phoneme groups
SCOPE OF OPERATING ON UNITS	whole word	whole stimulus	complete set of components or enough to guess word
ORDER OF OPERATING ON UNITS	probably an initial left-right scan	probably an initial left-right scan, though letter environments often operate right-to-left	generally, serial order as in complete word; or cumulative blending of successive sound components; or chunking into VC(C) units or syllables and blending the "chunks"
RELATIONS AMONG UNITS	letter groupings; (see text)	conditioning letter environments, especially for vowels; in two-syllable words, stress placement, perhaps accompanied by vowel reduction	irrelevant features of component sounds must be eliminated; relevant features must be integrated; in multi-syllable words, stress must be properly assigned, and vowels may be reduced
SHORT-TERM MEMORY REQUIREMENTS	none	a given letter and its conditioning environment in memory at the same time	memory for component sounds about to be blended
LONG-TERM MEMORY REQUIREMENTS	segmentation strategies; consonant/vowel distinction	letter-sound correspondences, with their conditioning environments	memory for sounds of words as an aid to guessing, especially if words are retrievable according to fragments
PATTERN RECOGNITION REQUIREMENTS	letters; letter clusters as unitary patterns	letters as sets of letters treated as units	extraction of relevant features from component sounds
PRE-REQUISITE TASK	none	in novel word decoding: visual segmentation (may be concurrent with sound assignment)	in novel word decoding: visual segmentation and assignment of sounds to letters

TASK	sight-word identification	reading stories
STIMULUS	visual word	prose and accompanying pictures
FUNCTIONAL UNITS WITHIN STIMULUS	sets of letters within word, or perhaps whole word as a single unit	words, phrases, sentences, paragraphs; pictures and picture elements; a page of text and a related picture as a conceptual unit
SCOPE OF OPERATING ON UNITS	whole word	a whole passage or a whole book, including several sentences and pictures
ORDER OF OPERATING ON UNITS	If word is analyzed into components, order of processing may be as described under first three topics	for prose: left-right and top-bottom in general, but also regressions for pictures: sequential scanning of successive pictures; undetermined order of scanning elements within each picture
RELATIONS AMONG UNITS	a unique serial order, outline shape, and pattern of internal features for the letters of at least part of the word	syntactic and semantic relations among words relations between words and pictures (see text)
SHORT-TERM MEMORY REQUIREMENTS	none specific to sight-words	short-term buffer for interpreting sets of words (perhaps a complete constituent structure) simultaneously
LONG-TERM MEMORY REQUIREMENTS	visual memory for the word	memory for general story line
PATTERN RECOGNITION REQUIREMENTS	recognition of the word as a visual pattern	letters and perhaps letter clusters and words; objects and spatial relations in pictures
PRE-REQUISITE TASKS	none	word decoding

TASK	comprehension questions	selecting a target among alternatives
STIMULUS	questions given orally or visually	target and alternatives presented visually or orally; items may be letters, word fragments, words, etc.
FUNCTIONAL UNITS WITHIN STIMULUS	key words and phrases within the question (see text); alternative responses in a multiple-choice question	component letters and/or sounds
SCOPE OF OPERATING ON UNITS	complete scanning of the question; partial sampling of the story or passage, or memory for it (see text)	all the alternatives may be examined before selection, or a match may be found before all are examined, and the rest of the alternatives may be ignored
ORDER OF OPERATING ON UNITS	an initial scan of question first, then alternative responses (if given), then story or memory	uncertain; perhaps a left-right bias, perhaps bias for first and last alternatives
RELATIONS AMONG UNITS	unknown (see text)	relations between target and correct alternative; identity, correspondence, part-whole relation among alternatives; maximally dissimular or common elements (see text)
SHORT-TERM MEMORY REQUIREMENTS	memory for the question, if presented orally	memory for target and/or alternatives if not usually available; perhaps memory for a decision about each alternative before final selection is made
LONG-TERM MEMORY REQUIREMENTS	memory for the story	letter-sound or sound-letter correspondences if target and alternatives are in different modalities
PATTERN RECOGNITION REQUIREMENTS	none	recognizing the correct alternative (see text)
PRE-REQUISITE TASKS	word decoding and story comprehension	none

mostly self-explanatory, but one comment should be made concerning "scope of operating on units." This is intended to suggest how much of the stimulus is processed in order for the task to be completed.

The table itself contains the bulk of the analysis presented in this section of the paper. The following discussion adds comments to clarify the entries, especially those marked "see text." It may be easiest to follow the analysis by reading each column of the table before the corresponding commentary.

Visual Segmentation

When a word is divided into sets of letters, various grouping principles may be used. Adjacent vowels or adjacent consonants may be grouped together. VC(C) or Vr clusters may be grouped. Letters corresponding to a syllable in a multi-syllable word may be clustered by grouping around a vowel nucleus. A set of letters may be grouped that has been learned by sight, with little regularity according to letter-sound correspondences. The use of particular groupings will depend in part on segmentation strategies which have been taught and which therefore would be stored in long-term memory. Some possible strategies are C/VC(C) or C/V/C(C) for many one-syllable words and division of the consonants between vowel nuclei in multi-syllable words. Another demand on long-term memory would be in recognition of sight-word sets of letters having unique letter-sound correspondences.

Assigning Sounds To Letters

The memory requirements of this task deserve some comment. In a word, the sound value of a letter or letter cluster often depends on the

letters around it. To determine the correct sound, some representation of the conditioning environment should therefore be in memory when the target letter or letter cluster is being decoded. The letter-sound correspondences themselves have been taught and reside in long-term memory. They may be organized there in various ways. As Cronnell (1971) points out, many correspondences are generalizable across several grapheme units; for example, the pattern of final VCe prescribed the long sound for vowels in general. Koehler (1971) has described in hierarchical structure for organizing and retrieving letter-sound correspondences. The primary classifications in the hierarchy are vowel/consonant and single letter/digraph.

Blending

The first three tasks--visual segmentation, assigning sounds to letters, blending--are components of decoding novel words, those which have been encountered infrequently or not at all and which are not recognized as unitary wholes. Blending is the final stage of novel word decoding. The output of this final stage is production of the sound of a word, smoothly articulated by eliminating irrelevant features of component sounds (for example, schwas following stops) and integrating the relevant features in accord with articulatory constraints and phonological knowledge.

Sight-Word Identification

At least some letters in a sight-word are irregular with respect to letter-sound correspondences and have little generality to other words.

However, some letters, especially consonants, may retain their regular sound values. Accordingly, a sight-word may be broken into a regular and an irregular component. It is possible that the regular component provides at least a partial clue to the identity of the word. A regular initial consonant, for example, might restrict memory search to a subset of all known words, thus allowing more efficient identification of the target word.

Reading Stories

The meaning of the text is probably derived by operating on sets of words simultaneously rather than successively. There is thus a demand on short-term memory. The child would scan the text (identifying the words at least in some partial way) in order to decide what words to interpret together. The initial reader is under a handicap in this process because simply decoding the printed words is a challenge. Constructions that would exacerbate the problem are lengthy or discontinuous constituents, relative clauses without relative pronouns, and written forms that are different from spoken ones. As explicit cues to the structure of sentences, the child may rely on key function words and on the conventions of punctuation and capitalization.

To understand the overall meaning of the story, the child must relate successive sentences and pages to each other. He must formulate a cognitive structure that persists at least during the time he is reading the story. Comprehension will be difficult as a function of the complexity of the plot, which in turn will depend on the number of characters, their relations to each other, the number of incidents, and

similar factors. An effective strategy for deriving the gist of the story may be for the child to cumulate the meaning of successive passages as he reads. Another effective approach (though perhaps a questionable one on pedagogical grounds) may be reliance on pictures. Especially at the outset of reading instruction, when the child has only a small vocabulary available, the pictures may be the vehicle for carrying the plot, with the words only commenting on them; later, the roles are reversed. At the early stages, it may be more effective for the child's comprehension of the story to scrutinize the pictures, decide on the plot (perhaps with the teacher's help), and then go back and read the words.

Comprehension Questions

Comprehension questions may be classified as factual, inferential, or interpretive depending on the information to be derived from the text. To fully describe the process of answering inferential or interpretive questions, there should be a model of the child's conceptual structure of the story, a description of his representation of the question, and a means of relating the two. Such matters are beyond the scope of this paper. It is easier to consider factual questions. In this case, a direct scan of the words in the text may be useful. This kind of question would benefit from availability of the text and from a match with the lexical and syntactic form of the text. Within the question, the child may focus on key words and phrases. These in turn may direct him to relevant sections of the text or to particular memories for it. For example, questions containing the interrogative word "who" may

direct the child to a list of names in memory or to capitalized words (signaling names) in the text. "Where" questions may direct him to objects of sentences; questions about what was said, to quotations.

Selecting A Target Among Alternatives

This may be considered a pattern recognition problem in which one instance of a type is used as a cue for selecting another instance. Several relations are possible between the target and the correct alternative. If both are in the same modality, the relation is one of identity, and the task is simply matching. If target and alternatives are in different modalities, the child must use the letter-sound or sound-letter correspondences relating them. Finally, a part-whole relation is possible; the target may be a component of one alternative, or the correct alternative may be a component (for example, selecting the word that starts with a c, or selecting the letter that the word cat begins with). In the case of the part-whole relation, the child may have to segment an item visually or phonetically and perhaps focus on a letter or sound at a specified serial position.

Two types of relations may also hold among the alternatives themselves. They may be maximally dissimilar. Or they may have elements in common. In the latter case, the task may be intended as a discrimination or concept learning problem in which the child is supposed to notice the syntagmatic/paradigmatic relations between the common elements and their environments. It is debatable whether the child learns more about the common or dissimilar parts of the alternatives.

GENERAL FACTORS IN INITIAL READING PROCESSES

In this section of the paper, an attempt is made to describe factors that are common to more than one process in initial reading. This generalization may be considered a pooling of functional units of various types; the same factor may apply to individual letters as well as to whole words, for example.

Segmentation

The total array of the printed text must be segmented into units of manageable size. There are overt, physical cues for parsing the text into paragraphs, sentences, words, and letters. It is more difficult to divide a word into letter clusters for decoding or a sentence into groups of words for comprehension. For words, segmentation strategies may be established for various word types, specific letter clusters may function as unitary patterns (e.g., qu, th, geminate consonants), and relations may hold among classes of letters (e.g., VCe, Vr). For sentences, constituent structures might serve as functional units.

Lookups

This factor is analogous to performance in a paired-associate task with the associations stored in long-term memory. The stimuli (or retrieval cues) may be letters, letter clusters, or words. For letters and letter clusters, the responses are component sounds. For words, the responses are meanings. This factor highlights the need for fast retrieval of many pieces of information cued by visual displays. The organizational

schemes suggested above for letter-sound correspondences may facilitate the retrieval process, and attention to the meaningful context of a sentence should facilitate retrieval of word meanings.

Short-Term Storage

The items held in short-term store may be component sounds or the words of a phrase. Sounds may be temporarily stored before blending, and words (or their meanings) may be stored before interpreting the phrase. Short-term store may thus serve as a "scratch-pad," holding elements to be organized in further processing (Venezky & Calfee, 1970). The serial order of the elements must also be presented. And it may be necessary to rehearse the elements to prevent forgetting.

Scanning For A Target

This factor applies to two varieties of instructional tasks: selecting a target element among given alternatives and answering comprehension questions. As described above, the target and the elements in an array of alternatives may be letters, word fragments, of words presented visually or auditorily. A general strategy for approaching the task might be to put target and alternatives in the same form and then match them. The transformation might be intermodal, based on sound-letter or letter-sound correspondences. Or it might be a segmentation process if there is a part-whole relation between target and alternatives. Comprehension questions often require a scan of the text (or memory of it) for specific information. As suggested above, if there are particular cues by which the desired information can be recognized, the scanning may involve a visual search of the text.

Search For Underlying Structure

Initial reading may be considered a series of abstractions that are hierarchically organized. At the lowest level, component sounds are integrated to form words according to phonological rules. At the next higher level, words combine to form phrases and sentences in accord with semantic restrictions and syntactic patterns. Finally, at the highest level, sentences are integrated according to the logical structure of a story of exposition. Progressing through successive stages of this hierarchy requires gestalt-like shifts of focus from components to the structures in which they are embedded. The difficulty of making such shifts highlights the difficulty of operating at various levels in initial reading. There are probably no procedures for teaching all the levels of abstraction as a single process. However, instruction could be addressed to each level separately (blending, comprehension of words, phrases, sentences, and stories). At each level, it should be clear to the child that components function with respect to the larger structure. Strategies that would take the larger structures into account include the following.

1. Left-to-right and right-to-left sequencing. The order of processing letters, words, and sentences is generally from left to right. There are also dependencies that operate from right to left, however. This is especially true of phonological constraints; a letter or the sound it represents can influence the pronunciation of another letter occurring earlier in the word. At the level of sentences, processing is more clearly left-to-right, but there are cases of right-to-left dependencies as well. The meaning of a word may be ambiguous

until later words have been read, and ocasionally a pronominal referent occurs after the pronoun. Similarly, the meaning of a statement or event in a story may be significant only in terms of what happens later.

These considerations suggest that although left-to-right processing is the fundamental order in reading, a right-to-left sequence is also necessary. In the case of words, an effective strategy might be two left-right sequences, with the second taking into account dependencies marked on the first. Or all the letters of a word might be processed in parallel, especially as the child acquires skill in visual pattern recognition and decoding. In the case of sentences and story comprehension, regressions may be useful, but it would be more efficient if the child could rely on memory for the text.

2. Cumulative chunking. It may be useful for the child to cumulatively integrate the elements being processed rather than wait until all of them are available. For words, this strategy would mean blending component sounds successively into one expanding chunk. At higher levels, it would mean pausing to integrate what has been read before the end of of a sentence or before the end of a story. The advantage of this strategy is its aid to memory in reducing the number of separate elements to be stored.

3. Partial cues as effective stimuli. The child may rely on selected features of the text in decoding and comprehending it. Particular features of individual letters may serve as the effective stimuli for identifying the letters. Sight-words may be identified by distinctive sets of letters rather than by the total pattern of the whole word. At the level of sentence comprehension, key words may cue syntactic structures. For example, a relative pronoun may cue a relative

clause; a noun determiner may cue a noun phrase. Punctuation capitalization, and paragraphing can also provide cues to the structure of the text.

4. Hypothesis testing. Because there are structures organizing the functional units encountered in reading, the child can make intelligent guesses about a word, a phrase, or a story line before identifying all their elements. This is probably inadvisable at the beginning of reading instruction, when the goal is for the child to master the use of the graphic information in the text. There is some evidence, moreover, demonstrating that children go through a first stage in reading in which their oral reading errors, although contextually appropriate, are relatively unconstrained by the printed letters (Biemiller, 1970). After the child has attained some proficiency in decoding, however, it may be useful for him to rely on some hypothesis-testing strategies. Rundle (1972), for example has suggested the use of a "generator-test" procedure in the second year of Mod 2 word attack instruction. According to this procedure, the child would try out a variety of vowel sounds after identifying the consonants in a given word. This is intended to reduce the number and complexity of the letter-sound correspondences the child handles. Cronnell (1970) has also suggested the use of a heuristic strategy. He describes an order for testing possible stress distributions and vowel rules when decoding multi-syllable words.

At some advanced point in reading, as an approximation of the adult model, hypothesis-testing might reduce the need for complete

identification of each word in a sentence. And at the level of story comprehension, it might provide an occasion to integrate what has been read and to motivate the reader to find out what will happen next.

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